June 2000

United States
Department of
Agriculture

Natural
Resources
Conservation
Service

**Watershed
Science
Institute**

Waterborne Pathogen Information Sheet

Principal Pathogens of Concern

Cryptosporidium and *Giardia*

What are *Cryptosporidium* and *Giardia*?

These organisms are protozoa. They are microscopic, single-celled organisms that belong to the kingdom Protista (fig. 1). *Cryptosporium* and *Giardia* are found throughout the world and can coexist in the same animal. They also have a low infectious dose necessary to infect humans, with possibly as few as 10 organisms in some cases. These organisms also produce a waterborne cyst *(Giardia)* or oocyst *(Cryptosporidium)*.

Why be concerned about *Cryptosporidium* and *Giardia*?

These two organisms are important disease-causing parasites of humans. Both can cause mild to severe diarrhea. No specific drug therapy has proven to be effective, but people with healthy immune systems generally recover in a week. Individuals that have a weak immune system may be unable to clear the parasites and, therefore, suffer chronic and debilitating illness. These organisms are highly resistant to chlorination, and filtration is not always adequate. This was the case in an outbreak in Milwaukee in 1993, the largest waterborne disease outbreak reported in the United States. An estimated 400,000 people were reported ill.

These waterborne pathogens are a particular management concern at the watershed scale where they may remain viable and are potentially amplified by agricultural practices.

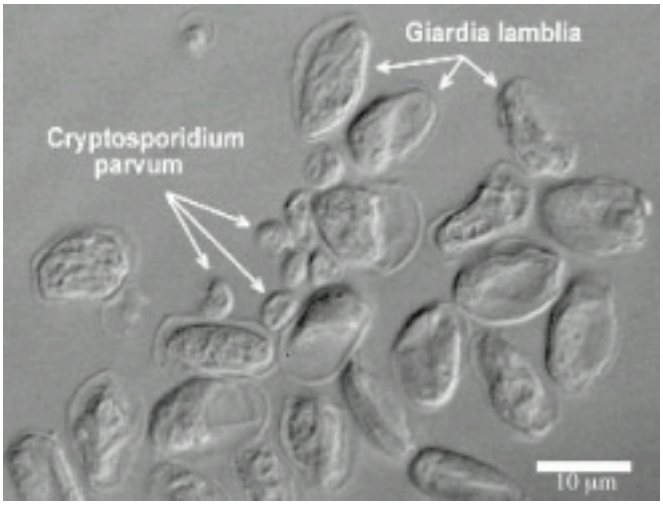


Figure 1 Cryptosporidium and Giardia as seen with a microscope (scale bar is 10 micrometers)

Cryptosporidium and *Giardia* hosts

Cryptosporidium parvum infects many mammal species. It can cause illness in young ruminants, especially calves, dogs, horses, and humans. One strain of *Cryptosporidium parvum* identified is only passed between humans. *Cryptosporidium parvum* is the only species of concern in mammals, while other species of *Cryptosporidium* are found in birds, fish, and reptiles.

Giardia species infects the intestinal tract of humans, dogs, cats, bears, muskrats, and beaver as well as some birds, reptiles, and amphibians.

Causes of waterborne outbreaks

Although there are several waterborne pathogens, most disease outbreaks from pathogens are associated with foodborne contamination. Only two reported waterborne outbreaks have been directly linked to farms.

Human contamination or inadequacies at water treatment plants have been implicated in the previous large-scale waterborne outbreaks. Most current waterborne outbreaks are associated with swimming pools and recreational waterbodies (lakes and rivers).

Most waterborne pathogens are in human and animal feces and enter water along certain pathways. Important pathways include defecation in waterbodies, where the pathogen is carried by overland flow and/or subsurface waterflow.

General measures for the control of pathogens in manure

A multiple-barrier approach can be used to help control pathogen transport and proliferation. Four control points are illustrated in figure 2:

- Pathogen import to the farm, which is intended to prevent the initial infection by these organisms.
- Breaking the cycle of pathogen amplification or proliferation in the animal operation.
- Appropriate waste management.
- Pathogen export or transport from the farm.

These control points should not be treated separately. For example, waste management is an important part of the amplification/proliferation control point when feed becomes contaminated with waste. Waste management also is an important part of the export control point; adequate treatment, such as composting, may kill the pathogens before they leave the farm.

Specific practices for *Cryptosporidium* and *Giardia*

Protozoan cysts and oocysts can persist for several months in water. For *Cryptosporidium*, management strategies should be designed to minimize direct livestock contamination of surface water, especially with young animals (less than 3 months of age). These efforts should focus on cowherds when calves are present. The handling of calves and their manure are the critical points of control with *Cryptosporidium* and several other pathogens. In addition, oocysts die when they dry out. Manure storage and application practices that allow for drying also reduce this pathogen.

Giardia is more widespread than *Cryptosporidium* in surface water. The primary source(s) of *Giardia* has not been demonstrated. As a precaution, the same manure management practices used for *Cryptosporidium* should be followed for *Giardia.*

Land application of waste

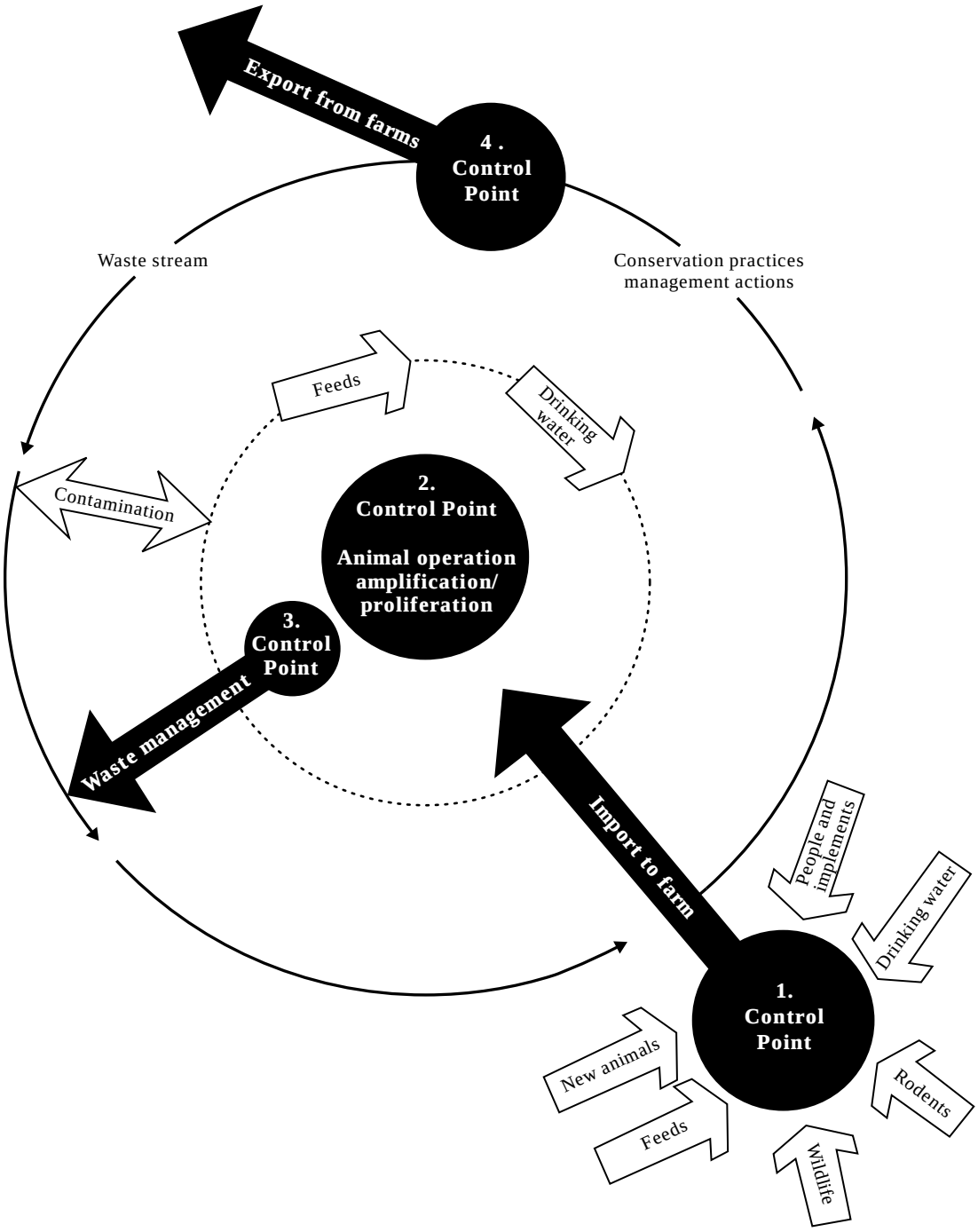
The main strategy for managing the waste stream following storage and/or treatment is to control the release of pathogens from the waste application areas. Climatic conditions, application technique and timing, and where applications are made are the major considerations for minimizing the loss of micro-organisms in runoff and leaching. For a detailed review of restricting features that need to be considered during waste application, the Agricultural Waste Management Field Handbook chapter 5, table 5–3 should be consulted.

On cropland, two approaches should be considered depending on the field conditions that will most likely follow application. When storm events are anticipated, the waste should be incorporated into the soil. This allows the reduction of potentially harmful organisms through adsorption, filtration, and attack from predator organisms. Direct incorporation also reduces the potential for surface applied waste to be carried

away by surface runoff. Incorporating surface-applied waste or injection of waste effectively moves organisms into the soil profile.

A second approach to waste application can be taken when soils are dry and at summer temperatures. Surface application without incorporation allows significant pathogen die-off because of exposure to UV light and desiccation.

Figure 2 Multiple-barrier points for pathogen control in agricultural operations



Conservation practices

Several conservation practices have a role in reducing pathogen load in a watershed (table 1). Details on each conservation practice are available from the NRCS National Handbook of Conservation Practices. From a watershed perspective, any practice that reduces runoff and erosion will reduce the transport of pathogen directly to surface water.

For more information, see *Waterborne Pathogens in Agricultural Watersheds*—a Watershed Science Institute Technical Note.

Visit the Watershed Science Institute Website:
http://gneiss.geology.washington.edu/~nrcs-wsi/

Table 1 Multiple-barrier approach and selected conservation practices that can reduce pathogen loading to watersheds

Practice*	Import control (source)	Amplification/ proliferation	Waste management	Export control (transport)
Composting Facility (317)		**x**	**xxx**	**x**
Constructed Wetland (656)			**x**	**xxx**
Filter Strip (393) and Grassed Waterway (412)				**xxx**
Residue Management (329 & 344)			**x**	**xxx**
Riparian Buffers (390 & 391)				**xxx**
Nutrient Management (590)			**xxx**	
Sediment Basin (350)				**xxx**
Waste Management System (312) including Waste Storage Facility (313) Waste Treatment Lagoon (359) Waste Utilization (633)		**xxx**	**xxx**	
Irrigation Water Management (449)				**xxx**
Prescribed Grazing including Use Exclusion (472) and Fence (382)			**xxx**	**xxx**

* Example practices selected from the NRCS National Handbook of Conservation Practices (number indicated). A single **x** indicates an indirect relation to pathogen control, while **xxx** indicates a direct relationship between a practice and pathogen control. Additional practices may also be appropriate.